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(54) **SEQUENCED ADJUSTABLE VOLUME PUMPS, REFILL UNITS AND DISPENSERS**

(71) Applicant: **GOJO Industries, Inc.**, Akron, OH (US)

(72) Inventors: **Nick E. Ciavarella**, Seven Hills, OH (US); **Jonathan E. Fawcett**, Stow, OH (US)

(73) Assignee: **GOJO Industries, Inc.**, Akron, OH (US)

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A47K 5/12	(2006.01)
A47K 5/16	(2006.01)

(52) **U.S. Cl.**

CPC ***A47K 5/12*** (2013.01); ***A47K 5/16*** (2013.01)

(58) **Field of Classification Search**

USPC 222/190, 401, 189.11, 383.1, 383.3, 222/394, 399

See application file for complete search history.

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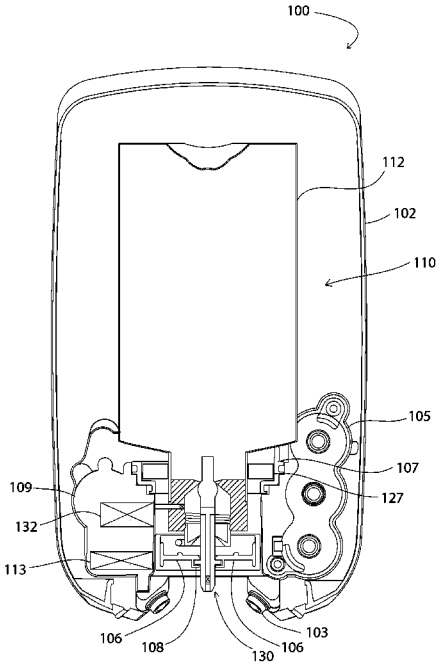
Primary Examiner — Donnell Long

(74) *Attorney, Agent, or Firm* — Calfee, Halter & Griswold LLP

(57) **ABSTRACT**

Embodiments of sequenced foam pumps, refill units and dispensers are disclosed herein. One exemplary refill unit includes a container for holding a foamable liquid and a sequenced pump. The sequenced pump has a housing with a chamber located within the housing. There is an air inlet and a liquid inlet into the chamber. A hollow valve stem is movable within the chamber. A sealing member forms a seal between the valve stem and the chamber. When the valve stem is in a first position liquid flows into the chamber and air in the chamber flows into the container; and when the valve stem is in a second position, the sealing member seals off the liquid inlet, and air travels through the air inlet and mixes with the liquid in the chamber. The air and liquid mixture travels through the center of the valve stem and out of an outlet.

23 Claims, 7 Drawing Sheets



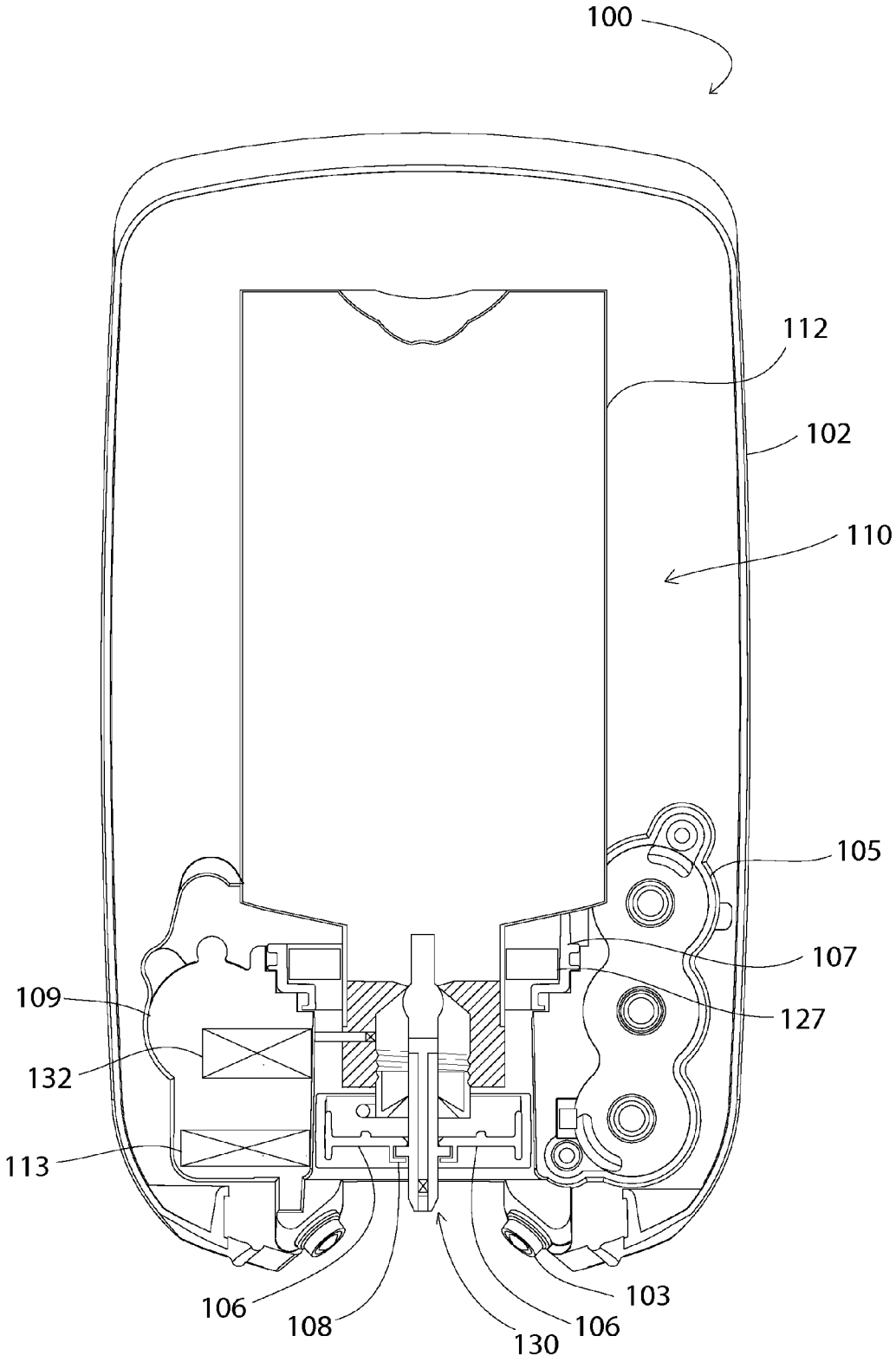
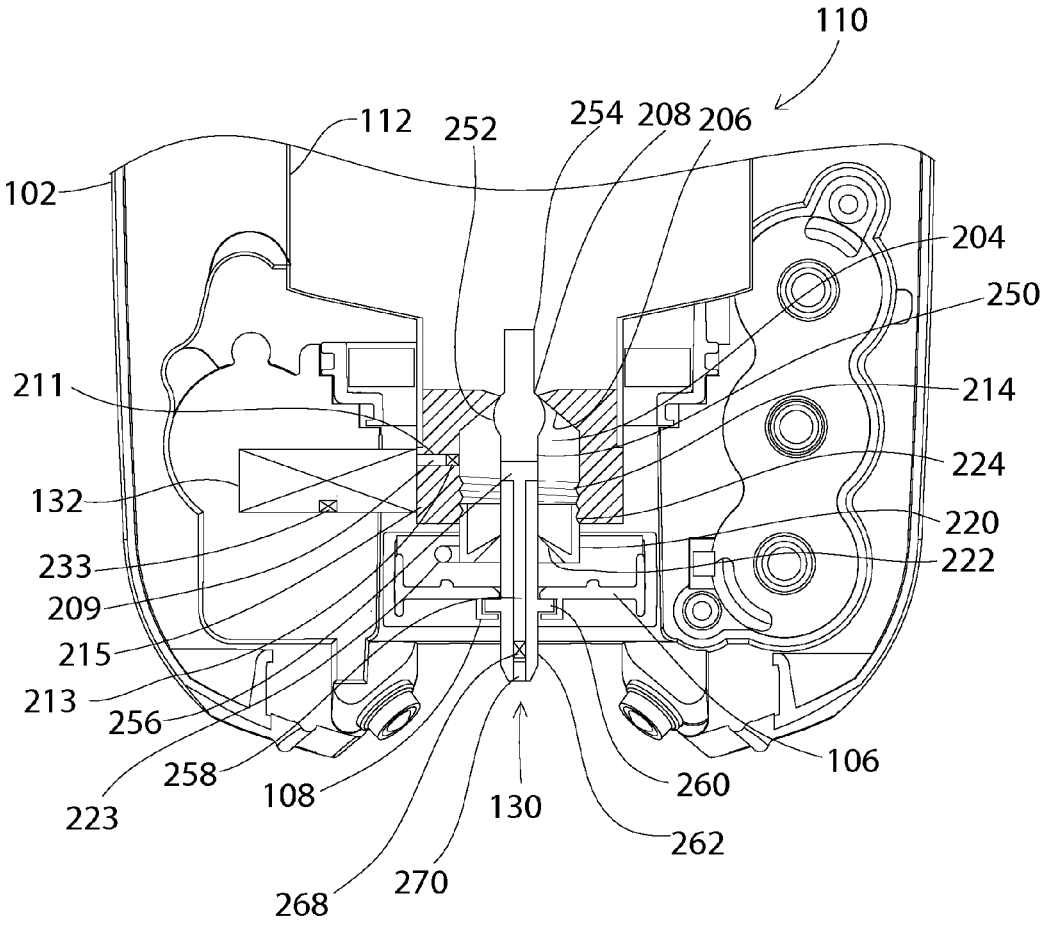


FIG. 1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208
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250
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214
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209
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213
256
258
223
108
130
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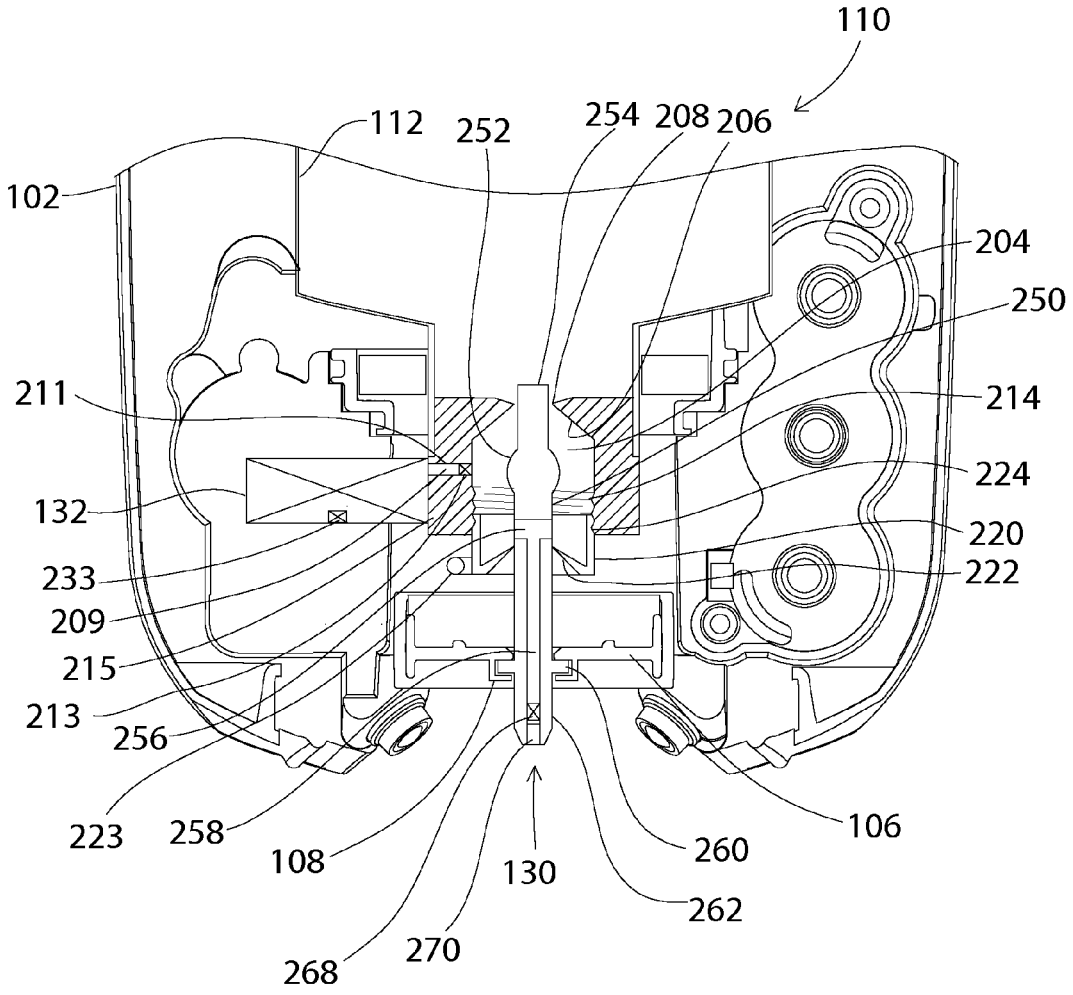
106
268
270

FIG. 2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268
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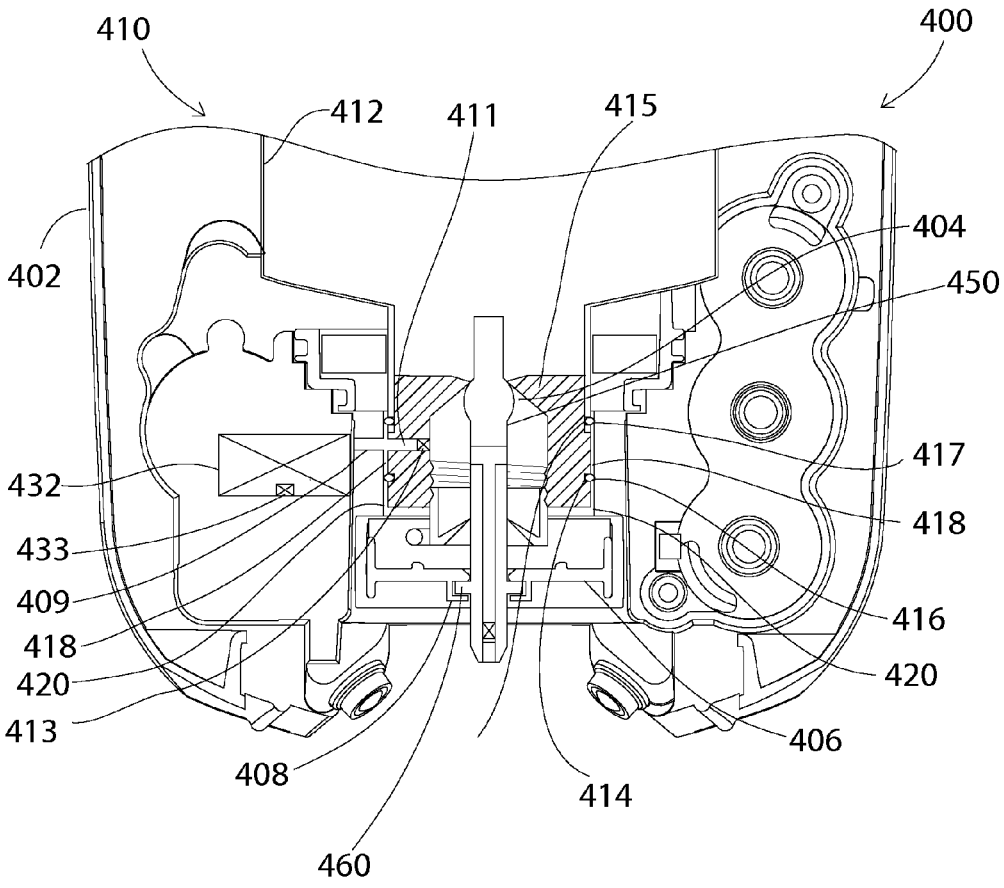
FIG. 3


410
400
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411
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432
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433
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420
413
406
408
414
460

FIG. 4

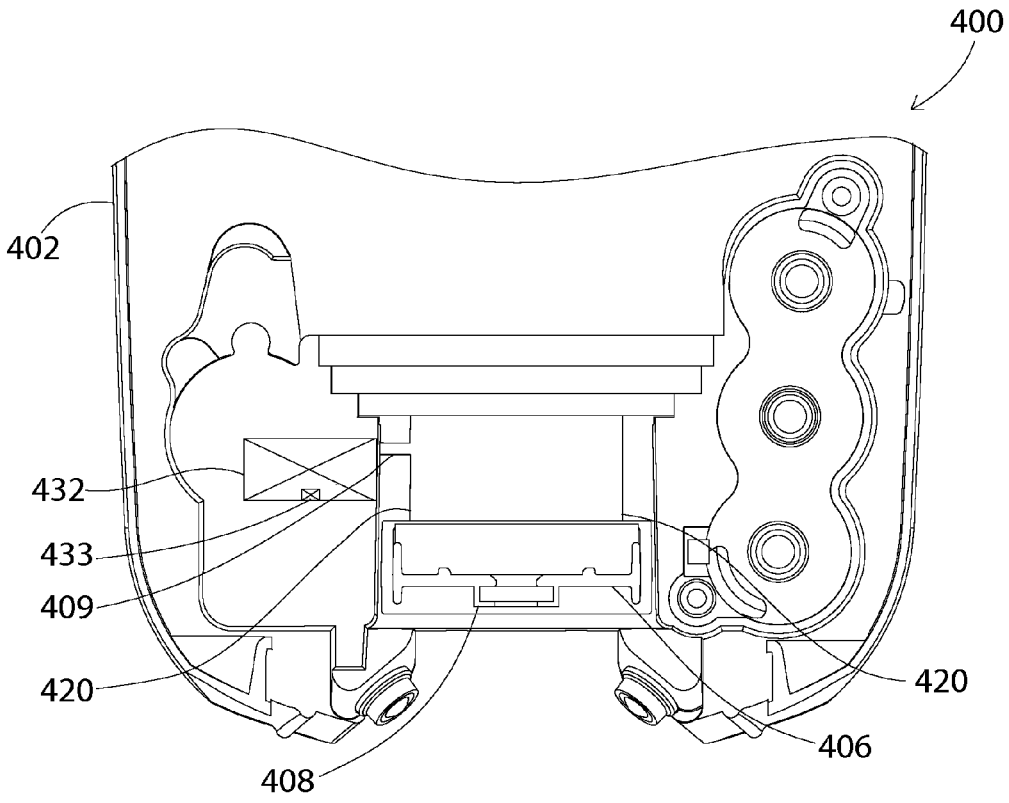

FIG. 5

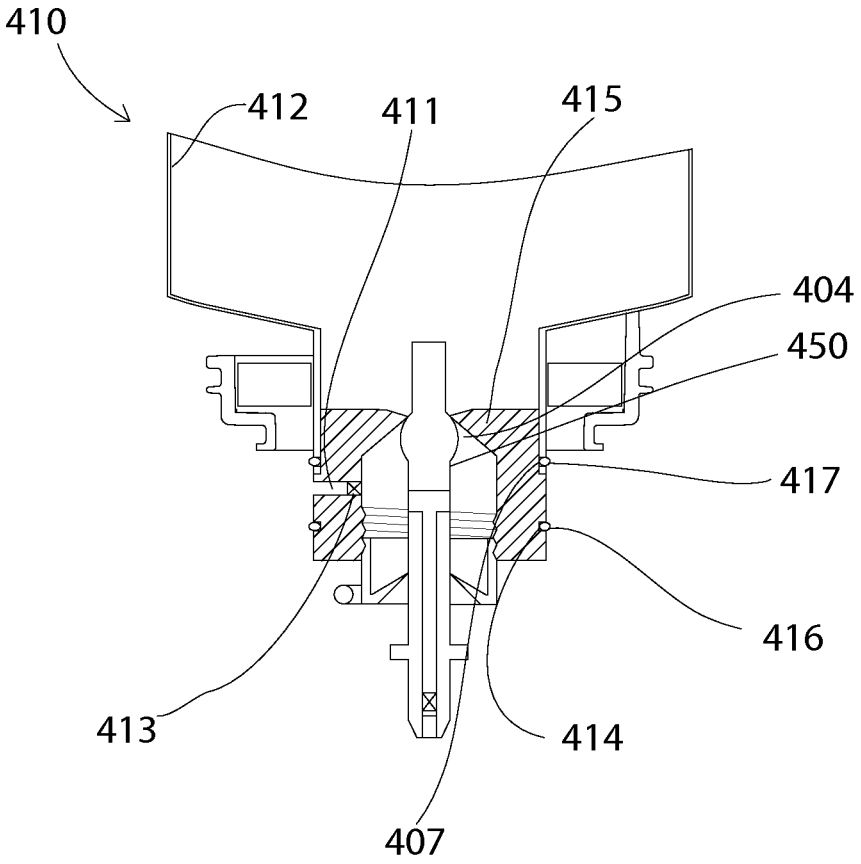

FIG. 6

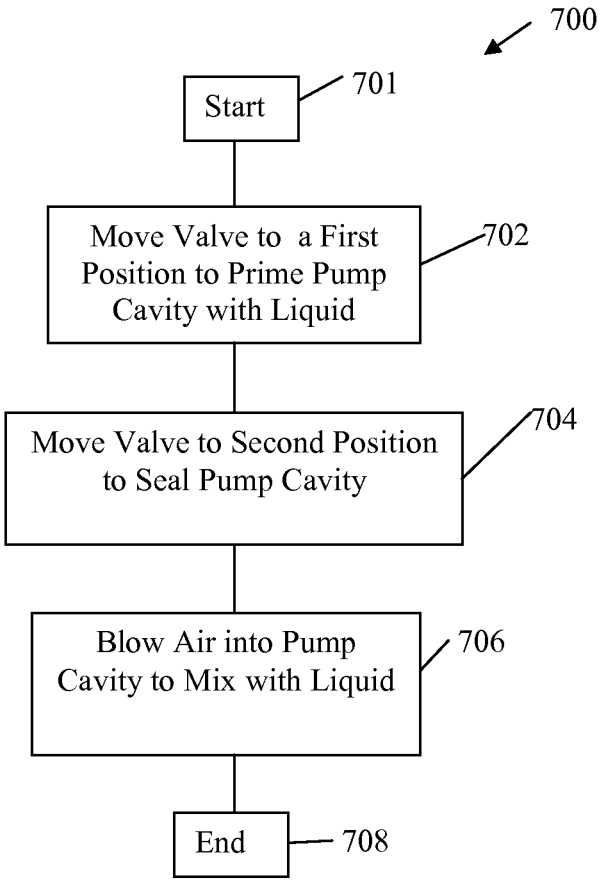
700
Start
701
Move Valve to a First Position to Prime Pump Cavity with Liquid
702
Move Valve to Second Position to Seal Pump Cavity
704
Blow Air into Pump Cavity to Mix with Liquid
706
End
708

Fig. 7

SEQUENCED ADJUSTABLE VOLUME PUMPS, REFILL UNITS AND DISPENSERS

TECHNICAL FIELD

The present invention relates generally to pumps, dispensers and refill units and more particularly to sequenced foam pumps, dispensers and refill units having sequenced foam pumps.

BACKGROUND OF THE INVENTION

Liquid dispenser systems, such as liquid soap and sanitizer dispensers, provide a user with a predetermined amount of liquid upon actuation of the dispenser. In addition, it is sometimes desirable to dispense the liquid in the form of foam by, for example, injecting air into the liquid to create a foamy mixture of liquid and air bubbles.

SUMMARY

Embodiments of sequenced foam pumps, refill units with sequenced foam pumps and dispensers utilizing sequence foam pumps are disclosed herein. One exemplary refill unit for a foam dispenser includes a container for holding a foamable liquid and a sequenced pump secured to the container. The sequenced pump has a housing with a chamber located within the housing. There is an air inlet into the chamber and a liquid inlet into the chamber. A valve stem having a hollow interior portion is movable within the chamber. The valve stem includes at least one aperture through the outside of the valve stem to the hollow interior of the valve stem. A sealing member forms a seal between the valve stem and the chamber. The refill unit also includes an outlet nozzle. During a first sequence, the valve stem is in a first position and liquid flows from the container into the chamber and air in the chamber travels into the container; and during a subsequent sequence the valve stem is in a second position, the sealing member seals off the liquid inlet, and air travels through the air inlet and mixes with the liquid in the chamber. The air and liquid mixture travels through the aperture and into the center of the valve stem and out of the outlet nozzle.

In addition, exemplary methods of producing a foam product using a sequenced foam pump are disclosed herein. One exemplary method of dispensing a foam product includes moving a valve stem to a first position to open a liquid inlet and allow liquid to flow from a container into a chamber and moving the valve stem to a second position to close the liquid inlet. The methodology includes forcing air under pressure into the chamber to mix with the liquid while the valve stem is in the second position and forcing the mixture to travel through a mix media and be dispensed out of an outlet as a foam.

An exemplary embodiment of a gravity-fed sequenced adjustable foam pump includes a housing, a liquid inlet into the housing, an air inlet into the housing and a valve stem movable within the housing. The valve stem is movable between a first position that seals off the liquid inlet and a second position that opens the liquid inlet. A sealing member is included for forming a seal between the valve stem and the housing. When the valve stem is in the first position, liquid flows into the housing through the liquid inlet. When the valve stem is in a second position, the liquid inlet is sealed off. When the valve stem is in the second position, air is forced into the housing and the air and liquid mixture is forced into a hollow center of the valve stem and is dispensed as a foam.

An exemplary embodiment of a self-venting refill unit includes a container for holding a liquid and a pump connected to the container. The pump includes a housing with a chamber located within the housing. The housing includes a liquid inlet and an air inlet. A valve stem is movable within the chamber. The valve stem moves from a first position that closes off the liquid inlet to a second position that opens the liquid inlet. Air from the air inlet passes into the chamber and mixes with the liquid and the air and liquid mixture are expelled from the pump as a foam; and when the valve stem moves back to the second position and opens the liquid inlet, air from the chamber flows into the container.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features and advantages of the present invention will become better understood with regard to the following description and accompanying drawings in which:

FIG. **1** illustrates a cross-section of an exemplary embodiment of a dispenser and refill unit for a sequenced foam pump;

FIG. **2** illustrates an enlarged view of the cross-section of a dispenser with a refill unit having a pump in the primed position;

FIG. **3** illustrates an enlarged view of the cross-section of a dispenser with the refill unit having the pump in a charging or priming position;

FIG. **4** is an enlarged view of a cross-section of another dispenser with a refill unit located therein;

FIG. **5** is a cross-section of the dispenser shown in FIG. **1** with the refill unit removed;

FIG. **6** is a cross-section of the refill unit of FIG. **1** removed from the dispenser; and

FIG. **7** illustrates an exemplary block diagram of a sequence for operating a foam dispenser.

DETAILED DESCRIPTION

FIG. **1** is a cross-sectional view of an exemplary dispenser **100** and a refill unit **110** for dispensing a foam. The foam may be any type of foam, such as, for example, a soap, a sanitizer or a lotion. The exemplary dispenser disclosed and described herein is an electrically-operated, touch-free dispenser **100**; however, other types of dispensers may be used, such as, for example, manually-operated dispensers. Manual dispensers may be actuated with a push bar, a lever, a pull actuator or the like provided that the dispenser contains suitable mechanisms to sequence the valve stem and air compressor as described herein.

Dispenser **100** includes housing **102**. Located within housing **102** is power supply **105**. Power supply **105** may be a 6 VDC power supply, such as, for example, a plurality of batteries. Optionally, power supply **105** may be a transformer and/or rectifier if the dispenser **100** is connected to, for example, a 120 VAC power source. In addition, dispenser **100** includes circuitry on circuit board **109**, an object sensor **103** and a motor **113** and associated gearing (not shown) to operate actuator **106** and air compressor **132**.

Dispenser **100** also includes a holder **107** for receiving a refill unit **110**. Holder **107** may include a retention mechanism, such as, for example, a rotatable lock ring (not shown) that rotates to engage and disengage with refill unit **110**. In such a case, a collar **127** is connected to refill unit **110** and may include engagement tabs (not shown) to releasably interlock with a rotatable lock ring.

Housing **102** includes an actuator **106** movable in an up-and-down motion by a motor **113** and associated gearing (not shown). In addition, motor **113** includes associated gearing

(not shown) for operating air compressor **132**. Optionally, a separate motor may be used to operate the air compressor **132**.

Refill unit **110** includes a container **112** for holding a foamable liquid and the wet end of foam pump **130**. The wet end of foam pump **130** comes into contact with the liquid. Dispenser **100** includes an integrated air compressor **132** that releasably mates with refill unit **110**. Air compressor **132** may be any type of air compressor, such as, for example, a piston pump, a diaphragm pump, a bellows pump, a dome pump, a rotary air compressor or the like. This exemplary embodiment is a split foam delivery system which allows the portions that come into contact with the liquid to be disposed of when the refill unit **110** is empty and isolates the air compressor from the liquid so that the air compressor may be permanently mounted in the dispenser and used to provide air for many refill units. In some embodiments, the air compressor is connected to and is part of refill unit **110**. In such embodiments, an actuator (not shown) in dispenser **100** is used to actuate the air compressor.

FIGS. **2** and **3** are enlarged views of a portion of the exemplary dispenser **100** and refill unit **110** installed in the dispenser **100**. Refill unit **110** includes a container **112**, a pump housing **215**, valve stem **250** and adjustable collar **220**. Refill unit **110** may be readily removed from the dispenser **100** by, for example, pulling the refill unit straight forward.

Pump housing **215** includes a pump cavity **204**. Pump cavity **204** includes an annular opening **208** surrounded by valve seat **206**. Annular opening **208** serves as a liquid inlet. In addition, pump housing **215** includes an air passage **211**. In some embodiments, a one-way air inlet valve **213** is located in air passage **211** and allows air to flow into pump cavity **204** but prevents air or liquid from flowing out of pump cavity **204** into air passage **211**. Accordingly, the one-way air inlet valve **213** prevents contamination or contact of the portions of the dispenser that remain with the dispenser housing when the refill unit is removed with liquid.

Pump housing **215** includes a threaded portion **214**. A collar **220**, which also includes a threaded portion **224**, mates with threaded portion **214**. Collar **220** includes a seal member **222**, which may be for example a wiper seal, an o-ring seal, a double wiper seal or the like. Collar **220** forms part of the boundary of pump cavity **204**.

Collar **220** is rotatable with respect to pump housing **215**. Clockwise rotation of collar **220** moves collar **220** upward which decreases the volume of pump cavity **204**. Counterclockwise rotation of collar **220** moves collar **220** downward and increases the volume of pump cavity **204**. In some embodiments, collar **220** also includes a tab or lever **223** that may be used to rotate collar **220**. The volume of pump cavity **204** may be set at the factory before shipping refill unit **110**, or may be field adjustable when installing a refill unit **110** in a dispenser **100**.

In one embodiment, the lever **223** may be used in the field to select a desired output dose. For example, if lever **223** is in the position illustrated in FIG. **2**, the refill unit **110** is set to dispense a full dose. If the lever **223** is rotated clockwise to a first position, the refill unit **110** is set to dispense a smaller dose and if the lever **223** is rotated until it reaches a stop (not shown), the refill unit **110** is set to dispense its smallest dose.

Pump **130** includes a valve stem **250**. Valve stem **250** is hollow and has one or more apertures **256** that lead to an interior passage **258**. Located within interior passage **258** is a one-way outlet valve **268**. Located downstream of one-way outlet valve **268** is a mix media **270**. Mix media **270** may be one or more screens, baffles, a porous member, a sponge or the like, to help agitate the liquid and air mixture being forced through the mix media to form a foam.

Valve stem **250** includes a bulb **252** and an upper guide portion **254**. In addition, valve stem **250** includes an annular projection **260** that is configured to engage with actuator **106**, which includes arms **108** for retaining annular projection **260** during operation. In some embodiments, bulb **252** is sized small enough so that during assembly, bulb **252** may be pushed up through sealing member **222** of collar **220** and large enough to seat against valve seat **206** of pump housing **215** to seal off pump cavity **204** from container **112**. Upper guide portion **254** may be cylindrical in shape, or may be formed as a plurality of ribs to allow for a greater fluid flow into pump cavity **204** when bulb **252** is not seated against valve seat **206** (as illustrated in FIG. **3**). In some embodiments, channels (not shown) may be added to upper guide portion **254** to allow greater fluid flow.

Dispenser **100** includes air compressor **132** with an air outlet **209**. Air outlet **209** engages with air inlet **211** of pump housing **215**. Air outlet **209** may be sealed with air inlet **211** by any means, such as, for example, a sealing member, a tight fit between pump housing **215** and dispenser **100**, a mating connection (not shown) or the like.

In some embodiments the air outlet **209** to the air compressor **132** of the dispenser **100** is located in the back of the dispenser **100**. The air outlet **209** may include a projection (not shown) that projects forward. The air inlet **211** of the pump housing **215** is located in the back of the refill unit **110** so that when the refill unit **110** slides into place, the air inlet **211** mates with the air outlet **209**. In such an example, the air inlet **211** may have a conical, or funnel shape and the air outlet **209** may have a projection that fits into the funnel shape and forms a seal. Another exemplary sealing mechanism is shown and described in FIG. **4**.

FIG. **4** illustrates another exemplary embodiment of a dispenser **400** having a refill unit **410** installed in the dispenser **400**. For the sake of simplicity, certain features that are similar to those described above are not re-identified and described again. The exemplary embodiment of the dispenser **400** includes an air compressor **432** and has a refill unit **410** installed in the dispenser **400**. The refill unit **410** includes a container **412**, a pump housing **415** and valve stem **450**. Pump housing **415** includes a pump cavity **404** having an air passage **411** and a one-way air inlet valve **413**. Pump housing has a first annular groove **407** located above the air passage **411** and a second annular groove **414** located below the air passage **411**. A first sealing member **417** (such as, for example, an o-ring) is located in first annular groove **407** and a second sealing member **416** (such as, for example, an o-ring) is located in second annular groove **414**. When the refill unit **410** is installed in the dispenser **400** the first and second sealing members **417**, **416** contact seal engagement member **420**, which may be a wall of dispenser **400** and provide a sealed air passage **418** between the air outlet **409** of air compressor **432** and the air inlet **411** of pump housing **404**. In this exemplary embodiment, the refill unit **410** is inserted by lowering the refill down into place with the actuator **406** pulled back to allow annular projection **460** to move into place and then actuator **406** moves forward to trap annular projection **460** between the bottom of actuator **406** and projection member **408**.

In some embodiments, valve stem **450** (or the other valve stems disclosed herein) includes a biasing member (not shown) to bias valve stem **450** upward. In such cases, projection **408** would not be needed to move the actuator **406** upward to seal off the pump cavity **404** from the container **412**.

In addition, in some embodiments, passage **418** only extends part-way around pump housing **415** and is sealed off by a portion of the pump housing **415** (not shown) that protrudes outward and seals against seal engagement member **420**. Thus, in such an embodiment, the refill unit **410** may be slid into the dispenser **400** from the front while still providing an air channel, such as air channel **418**, partly around the pump housing **415** and allowing for some misalignment of the refill unit **410** when inserting it into the dispenser **400**.

FIG. **5** is a cross-sectional view of the dispenser **400** without refill unit **410** installed. FIG. **6** is a cross-sectional view of refill unit **410** without the refill unit **410** being installed in the dispenser **400**.

The exemplary operation of the sequenced foam pump **130** begins during the refill or priming stage illustrated in FIG. **3**. Actuator **106** lowers the valve stem **250**, which includes bulb **252**, to allow foamable liquid to flow from container **112** into pump cavity **204**. Then the valve stem **250** and bulb **252** are moved upward by actuator **106** so that bulb **252** contacts and seals against valve seat **206**. Then air compressor **132** is actuated forcing air to flow through air compressor outlet **209**, into pump housing **215** through air inlet **211**, past air inlet valve **213** and into pump cavity **204**. The incoming air mixes with the foamable liquid and the liquid/air mixture flows through aperture **256**, through the passage **223** in valve stem **250**, past one-way outlet valve **268**, through mix media **270** and out of outlet **262** where it is dispensed as a foam.

At that point, air compressor **132** is stopped and re-primed. In some embodiments, such as, for example, if the air compressor **132** is a piston pump or a dome pump, as the air chamber (**132**) in the air compressor **132** expands, air flows into the air compressor **132** through a one-way air inlet valve **233**. As the actuator **106** moves the valve stem **250** and bulb **252** downward, air in the pump cavity **204** flows into container **112** thereby venting the container **112**, and liquid flows into pump cavity **204**. At this point, the pump **130** is primed and ready for another dispense cycle.

FIG. **7** illustrates an exemplary methodology for a sequenced foam pump operation **700**. Although the exemplary methodology discloses the steps in a certain order, the exemplary methodology is not limited to a certain process order, or to all of the steps listed in the exemplary methodology. In addition, additional steps, or sub-steps may be included. The sequence begins at block **701**. At block **702** the valve is moved to a first position to prime the liquid pump cavity with foamable liquid from a container. When the pump cavity is filled with foamable liquid, the valve is moved to a second position sealing the pump cavity at block **704**. An air compressor is activated at block **706** to force pressurized air into the pump cavity to mix with the liquid. The air pressure forces the liquid/air mixture to flow out of the dispenser and be dispensed as a foam.

While the present invention has been illustrated by the description of embodiments thereof and while the embodiments have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Moreover, elements described with one embodiment may be readily adapted for use with other embodiments. Therefore, the invention, in its broader aspects, is not limited to the specific details, the representative apparatus and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of the applicants' general inventive concept.

We claim:

1. A refill unit for a foam dispenser comprising:
a container for holding a foamable liquid;
a sequenced pump secured to the container;
the sequenced pump comprising:
a housing;
a chamber located within the housing;
an air inlet into the chamber;
a liquid inlet into the chamber;
a valve stem having a hollow interior portion;
at least one aperture through the outside of the valve stem to the hollow interior of the valve stem;
a sealing member that forms a seal between the valve stem and the chamber; and
an outlet nozzle;
wherein during a first sequence, the valve stem is in a first position and liquid flows from the container into the chamber, and air in the chamber travels into the container; and
wherein during a subsequent sequence, the valve stem is in a second position and seals off the liquid inlet from the container, and air travels through the air inlet and mixes with the liquid in the chamber; and
the air and liquid mixture travels through the aperture and into the center of the valve stem and out of the outlet nozzle.

2. The refill unit of claim **1** further comprising an adjustment member for adjusting the volume of the chamber.

3. The refill unit of claim **1** further comprising a mix media secured to the valve stem, wherein the mix media is in fluid communication with the interior of the valve stem.

4. The refill unit of claim **1** further comprising an air pump in fluid communication with the air inlet.

5. The refill unit of claim **1** further comprising a foamable liquid in the container.

6. The refill unit of claim **1** further comprising a valve stem guide member.

7. A method of dispensing a foam product comprising:
moving a valve stem to a first position to open a liquid inlet and allow liquid to flow from a container into a chamber;
moving the valve stem to a second position to close the liquid inlet;
forcing air under pressure into the chamber to mix with the liquid while the valve stem is in the second position; and
forcing the mixture to travel through a mix media and be dispensed out of an outlet as a foam.

8. The method of claim **7** further comprising venting the container by moving the liquid valve stem to the first position.

9. A gravity fed foam pump comprising:
a housing;
a liquid inlet into the housing;
an air inlet into the housing;
a valve stem movable within the housing;
the valve stem movable between a first position that seals off the liquid inlet and a second position that opens the liquid inlet;
a sealing member for sealing between the valve stem and the housing;
wherein when the valve stem is in the second position, liquid flows into the housing through the liquid inlet and air flows out of the housing;
wherein when the valve stem is in a first position the liquid inlet is sealed off; and
air is forced into the housing when the valve stem is in the second position and the air and liquid mixture is forced into a hollow center of the valve stem and is dispensed as a foam.

10. The gravity fed foam pump of claim 9 further comprising an air pump secured to the housing.

11. The gravity fed foam pump of claim 9 further comprising a container for holding a foamable liquid.

12. The gravity fed foam pump of claim 11 further comprising a foamable liquid in the container.

13. A self-venting refill unit comprising:
a container for holding a liquid;
a pump connected to the container;
the pump having a housing;
a chamber located within the housing
a liquid inlet;
an air inlet;
a valve stem movable within the chamber;
the valve stem moving from a first position that closes off the liquid inlet and a second position that opens the liquid inlet;
wherein air from the air inlet passes into the chamber and mixes with the liquid and the air and liquid are expelled from the pump as a foam; and
wherein when the valve stem moves to the second position and opens the liquid inlet, air from the chamber flows into the container.

14. The self-venting refill unit of claim 13 further comprising a sealing member to form a seal between the valve stem and the housing and form at least a portion of the chamber.

15. The self-venting refill unit of claim 14 wherein the air and liquid mixture passes through the center of the valve stem.

16. The self-venting refill unit of claim 15 wherein an outlet valve is located proximate the hollow center of the valve stem.

17. The self-venting refill unit of claim 16 wherein a mix media is located proximate the hollow center of the valve stem.

18. The self-venting refill unit of claim 15 further comprising a foamable liquid in the container.

19. A refill unit for a foam dispenser comprising:
a container for holding a foamable liquid;
a sequenced pump secured to the container;
the sequenced pump comprising:
a housing;
a chamber located within the housing;
an air inlet into the chamber;
a liquid inlet into the chamber;
a valve stem having a hollow interior portion;
at least one aperture through the outside of the valve stem to the hollow interior of the valve stem;
a sealing member that forms a seal between the valve stem and the chamber; and
an outlet nozzle;
wherein during a first sequence, the valve stem is in a first position and liquid flows from the container into the chamber, and air in the chamber travels into the container; and
wherein during a subsequent sequence, the valve stem is in a second position and seals off the liquid inlet from the container, and air travels through the air inlet and mixes with the liquid in the chamber;
the air and liquid mixture travels through the aperture and into the center of the valve stem and out of the outlet nozzle; and
an adjustment member for adjusting the volume of the chamber;
wherein the adjustment member includes the sealing member.

20. A refill unit for a foam dispenser comprising:
a container for holding a foamable liquid;
a sequenced pump secured to the container;
the sequenced pump comprising:
a housing;
a chamber located within the housing;
an air inlet into the chamber;
a liquid inlet into the chamber;
a valve stem having a hollow interior portion;
at least one aperture through the outside of the valve stem to the hollow interior of the valve stem;
a sealing member that forms a seal between the valve stem and the chamber; and
an outlet nozzle;
wherein during a first sequence, the valve stem is in a first position and liquid flows from the container into the chamber, and air in the chamber travels into the container; and
wherein during a subsequent sequence, the valve stem is in a second position and seals off the liquid inlet from the container, and air travels through the air inlet and mixes with the liquid in the chamber;
the air and liquid mixture travels through the aperture and into the center of the valve stem and out of the outlet nozzle; and
an adjustment member for adjusting the volume of the chamber;
wherein the adjustment member is rotatable to adjust the volume of the chamber.

21. A refill unit for a foam dispenser comprising:
a container for holding a foamable liquid;
a sequenced pump secured to the container;
the sequenced pump comprising:
a housing;
a chamber located within the housing;
an air inlet into the chamber;
a liquid inlet into the chamber;
a valve stem having a hollow interior portion;
at least one aperture through the outside of the valve stem to the hollow interior of the valve stem;
a sealing member that forms a seal between the valve stem and the chamber; and
an outlet nozzle;
wherein during a first sequence, the valve stem is in a first position and liquid flows from the container into the chamber, and air in the chamber travels into the container; and
wherein during a subsequent sequence, the valve stem is in a second position and seals off the liquid inlet from the container, and air travels through the air inlet and mixes with the liquid in the chamber;
the air and liquid mixture travels through the aperture and into the center of the valve stem and out of the outlet nozzle; and
an outlet valve secured to the valve stem, and the outlet valve is located at least partially within the interior of the valve stem.

22. A gravity fed foam pump comprising:
a housing;
a liquid inlet into the housing;
an air inlet into the housing;
a valve stem movable within the housing;
the valve stem movable between a first position that seals off the liquid inlet and a second position that opens the liquid inlet;
a sealing member for sealing between the valve stem and the housing;

wherein when the valve stem is in the second position, liquid flows into the housing through the liquid inlet;

wherein when the valve stem is in a first position the liquid inlet is sealed off; and

air is forced into the housing when the valve stem is in the second position and the air and liquid mixture is forced into a hollow center of the valve stem and is dispensed as a foam;

wherein the sealing member is movable between a first position and a second position, and movement of the sealing member from the first position to the second position changes the volume of foam dispensed from the pump.

23. A self-venting refill unit comprising:

a container for holding a liquid;

a pump connected to the container;

the pump having a housing;

a chamber located within the housing

a liquid inlet;

an air inlet;

a valve stem movable within the chamber;

the valve stem moving from a first position that closes off the liquid inlet and a second position that opens the liquid inlet;

wherein air from the air inlet passes into the chamber and mixes with the liquid and the air and liquid are expelled from the pump as a foam; and

wherein when the valve stem moves to the second position and opens the liquid inlet, air from the chamber flows into the container;

a sealing member to form a seal between the valve stem and the housing and form at least a portion of the chamber;

wherein the sealing member is movable within the chamber and the volume of the chamber may be adjusted by changing the position of the sealing member.

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